PROPULSION DIRECTORATE

Monthly Accomplishment Report
May 2006

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PATENT GRANTED FOR INFRARED THERMOGRAPHY TECHNIQUE: On May 9, 2006, US Patent 7,040,805 was granted to Drs. Shichuan Ou and Richard B. Rivir of the Propulsion Directorate and Dr. Srinath V. Ekkad* of the Louisiana State University, Baton Rouge, Louisiana. This patent, titled "Method of Infrared Thermography," describes an invention that uses a high resolution infrared thermography system to determine heat transfer coefficients and film effectiveness values from a single transient test. Film cooling, a cooling technique where a cool fluid is injected onto the hot surface through holes or slots provided within that surface, is used extensively in modern gas turbines to cool hot gas path components. As high performance turbine engine technologies advance, turbine inlet temperatures are increased to achieve higher thermal efficiency. These higher temperatures necessitate effective film cooling to protect the turbine components. Previous techniques for obtaining film cooled heat transfer coefficients and film effectiveness values have required two different, related tests. Such experimentation is costly, and any reduction in these costs by improving testing techniques is desirable. The new method described in this patent quickly and accurately provides film cooled heat transfer coefficient values and film effectiveness values from a single test. Also, this method avoids the use of expensive thermographic liquid crystals to provide temperature values. Furthermore, by enabling the designer to determine film cooled heat transfer coefficient values and film effectiveness values from a single test, the inaccuracies and uncertainties arising from running two different tests at two different times are reduced. (Dr. Shichuan Ou, AFRL/PRTT, (937) 255-6043 and Dr. Richard Rivir, AFRL/PR, (937) 255-2744)


Dr. Shichuan Ou


Dr. Richard Rivir

* Dr. Ekkad is an Associate Professor in the Department of Mechanical Engineering at the Louisiana State University.

AIAA TECHNICAL PRESENTATIONS HONORED: The awards from the 31st AIAA Dayton-Cincinnati Aerospace Sciences Symposium (DCASS) Technical Presentation Competition were recently announced, and the Propulsion Directorate's Dr. Jim Gord was among the winners. Dr. Gord was recognized for his presentation titled, "Temperature Measurements in Combusting Environments by Picosecond Coherent Anti-Stokes Raman Scattering," which was honored as the best presentation in the Imaging and Diagnostics category. Dr. Gord's co-authors on this work were Dr. Sukesh Roy and Dr. Terrence Meyer of Innovative Scientific Solutions, Inc. (ISSI). In addition, three other presentations that earned awards had AFRL/PR co-authors. These presentations are listed below with AFRL/PR personnel shown in **bold** type:

Authors	Title	Category
Aaron J. Glaser[†] Nicholas Caldwell[†] Ephraim Gutmark[†] John Hoke[‡] Royce Bradley[‡] **Fred Schauer**	Performance Measurements of Ejectors Driven by a Pulse Detonation Engine	Pulse Detonation Engines & Acoustics
Kevin Bray[§] Richard L.C. Wu[§] **Sandra J. Fries-Carr** **Joseph A. Weimer**	Aluminum Oxynitride Dielectrics for High Power, Wide Temperature Capacitor Applications	Structures
Vaughn Kunze[**] **Marc Polanka** Mitch Wolff[**]	Numerical Insight into Flow and Thermal Patterns Within an Inlet Profile Generator Comparing to Experimental Results	Turbomachinery

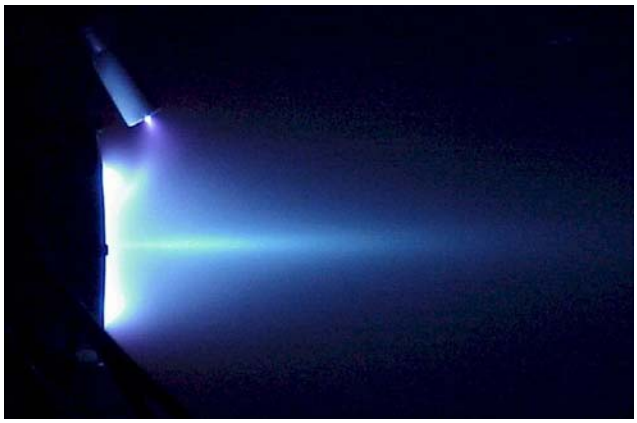
These awards were presented at the AIAA Dayton-Cincinnati Section Annual Awards Banquet held on May 25, 2006 at the University of Dayton. (Mr. Jeff Pearce, AFRL/PRO (UTC), (937) 255-5015)


Dr. Jim Gord

TACSAT-2 PROPULSION TESTING SUCCESSFUL: The Propulsion Directorate successfully fired the 200 W Hall Effect Thruster during spacecraft-level thermal vacuum testing at Kirtland AFB, New Mexico. The thermal vacuum test verifies the thermal design of the TacSat-2 spacecraft, and it also represents the only opportunity prior to launch to verify the thruster operation with the spacecraft. These tests are thus the final pre-launch validation that the spacecraft will support thruster firings of various durations without

[†] University of Cincinnati
[‡] Innovative Scientific Solutions, Inc.
[§] K Systems Corp.
[**] Wright State University

affecting other spacecraft operations. AFRL/PR has taken full advantage of this opportunity to test the Hall Effect Thruster and has performed numerous firings of varying duration over different temperatures regimes. The Hall Effect Thruster is an electric propulsion system featuring high specific impulse (approximately 1400 seconds for this design) and nominal thrust levels on the order of 13.5 milliNewtons. The system is very lightweight (approximately 8.5 kg dry mass), and it addresses the need to reduce the overall size and electrical power needs of orbiting spacecraft and satellites. Its primary use is to maintain orbit against drag. AFRL's Space Vehicles Directorate (AFRL/VS) is developing the TacSat-2 micro satellite as the first in a series to demonstrate the objectives of the joint warfighting space (JWS) initiative. The TacSat-2 spacecraft is scheduled to be launched later in 2006. (Mr. Daron Bromaghim, AFRL/PRSS, (661) 275-5907)


Hall effect thruster firing

PROPULSION DIRECTORATE HONORS ITS OWN: The Propulsion Directorate held its 8th Annual Awards Celebration on May 11, 2006. The ceremony, held at the Essex House in Lancaster, California, was attended by more than 100 people. The following awards were presented at the ceremony (listed in order of presentation):

Award	**Winner(s)**
NCO of the Year	TSgt Timothy J. Rowe
Senior NCO of the Year	SMSgt Ben J. Rosen
Duty First Sergeant Recognition Award	MSgt William T. Curtis
Reservist of the Year Award	Maj David W. Metzger
David A. Hawkins CGO of the Year Award	Capt Steven J. Bolster
Reserve Supervisor of the Year Award	Leonard C. Langdon
Technology Transfer Award	Dr. Wesley P. Hoffman
Mission Support of the Year Award	Mark E. Pennywitt
Program Manager of the Year Award	Paul J. Kennedy and Charles W. Frayne (tie)
Scientist and Engineer (S&E) of the Year Award	Dr. Timothy J. Haugan
Betty Siferd Support Award	Debra L. Fuller
Hart-Sims Program Management Award	Anthony P. "Paul" Zuttarelli
E.C. Simpson Award	F100 Blade Life Extension Team (Dr. Tommy J. George, Capt Andrew J. Jutte, Todd M. Morrison, Dr. Charles J. Cross, Brian D. Runyon, and Capt Sean S. Musil
Don Ross Award	Dr. Raymond H. Moszée
S.D. Heron Award	Dr. James R. Gord
Director's Trophy	Julie A. Carlile

Congratulations to all of the winners and nominees. (Mr. J. Pearce, AFRL/PRO (UTC), (937) 255-5015)

TSgt Timothy J. Rowe

SMSgt Ben J. Rosen

MSgt William T. Curtis

Capt Steven J. Bolster

Dr. Wesley P. Hoffman

Mark E. Pennywitt

Paul J. Kennedy

Charles W. Frayne

Dr. Timothy J. Haugan

Debra L. Fuller

Anthony P. “Paul” Zuttarelli

F100 Blade Life Extension Team

Dr. Raymond H. Moszée

Dr. James R. Gord

Julie A. Carlile

POWER DIVISION HOSTS INAUGURAL TECH NEEDS FORUM: The Propulsion Directorate's Power Division (AFRL/PRP) hosted the 1st Technology Needs & Investment Strategy Forum in Dayton, Ohio on May 9, 2006. The purpose of this forum was to share current investment strategies and present a detailed overview of planned new starts for late FY06 and FY07. The new start programs are focused in the areas of directed energy, aircraft, and other special purpose power applications. The forum garnered considerable interest, with more than 120 attendees from government, academia, and industry. AFRL/PR's Power Division is the primary source of power technology in the USAF and is a major contributor to allied research throughout the DoD. AFRL/PRP manages a full spectrum of Research & Development, including basic research, applied research, and advanced development programs. Technology development areas include power generation, power conditioning, energy storage, and thermal management. The Power Division pioneered the concept known today as the More-Electric Aircraft (MEA), replacing many hydraulic and pneumatic systems with electrically-driven systems. Today the Power Division is exploring future generations of MEA in the High Powered Aircraft (HiPAC) Program,

addressing the diverse power and thermal management needs of everything from micro-UAVs to directed energy weapons. (Mr. Brian Hager, AFRL/PRPA, (937) 255-4153)

JOURNAL ARTICLE GARNERS ATTENTION: A collaborative article between AFRL's Materials & Manufacturing (AFRL/ML) and Propulsion (AFRL/PR) Directorates is being featured by the journal *Energy & Fuels*. This article is featured in a very selective list of the most-accessed articles from 2005 in *Energy & Fuels*. Entitled "Quantitative Structure - Property Relationships for Melting Points and Densities of Ionic Liquids," the article was co-authored by AFRL/ML's Drs. Steven Trohalaki[††] and Ruth Pachter and AFRL/PR's Drs. Greg Drake and Tommy Hawkins. It presents relationships for the densities and melting points of energetic ionic liquids that can aid in the molecular design of new compounds. Ionic liquids have generated considerable interest as "green" alternatives in current industrial applications and as possible replacements for state-of-the-art energetic materials for explosives and rocket propellants such as hydrazine. A publication of the American Chemical Society (ACS), *Energy & Fuels* publishes reports of research in all areas of the chemistry of non-nuclear energy sources. (Dr. Tommy Hawkins, AFRL/PRSP, (661) 275-5449)

[††] Dr. Trohalaki is an on-site contractor in AFRL/MLPJ.